

# Gel and AGM Batteries

Energy Unlimited

www.victronenergy.com

## 1. VRLA technology

VRLA stands for Valve Regulated Lead Acid, which means the batteries are sealed. Gas will escape through the safety valves only in case of overcharging or cell failure.

VRLA batteries are maintenance free for life.

## 2. Sealed (VRLA) AGM batteries

AGM stands for Absorbent Glass Mat. In these batteries the electrolyte is absorbed into a glass-fibre mat between the plates by capillary action. As explained in our book 'Energy Unlimited', AGM batteries are more suitable for short-time delivery of very high currents (engine starting) than gel batteries.

## 3. Sealed (VRLA) Gel batteries

Here the electrolyte is immobilized as gel. Gel batteries in general have a longer service life and better cycle capacity than AGM batteries.

## 4. Low Self-discharge

Because of the use of lead calcium grids and high purity materials, Victron VRLA batteries can be stored during long periods of time without recharge. The rate of self-discharge is less than 2% per month at 20°C. The self discharge doubles for every increase in temperature with 10°C.

Victron VRLA batteries can therefore be stored during up to a year without recharging, if kept under cool conditions.

## 5. Exceptional Deep Discharge Recovery

Victron VRLA batteries have exceptional discharge recovery, even after deep or prolonged discharge.

It should however be stressed that repetitive deep discharge and prolonged discharge have a very negative influence on the service life of all lead acid batteries, Victron batteries are no exception.

## 6. Battery discharging characteristics

The rated capacity of Victron AGM and Gel Deep Cycle batteries refers to 20 hour discharge, in other words: a discharge current of 0,05 C.

The rated capacity of Victron Tubular Plate Long Life batteries refers to 10 hours discharge.

The effective capacity decreases with increasing discharge current (see table 1). Please note that the capacity reduction will be even faster in case of a constant power load, such as an inverter.

Discharg time (constant current)	End Voltage V	AGM 'Deep Cycle' %	Gel 'Deep Cycle' %	Gel 'Long Life' %
20 hours	10,8	100	100	112
10 hours	10,8	92	87	100
5 hours	10,8	85	80	94
3 hours	10,8	78	73	79
1 hour	9,6	65	61	63
30 min.	9,6	55	51	45
15 min.	9,6	42	38	29
10 min.	9,6	38	34	21
5 min.	9,6	27	24	
5 seconds		8 C	7 C	

**Table 1: Effective capacity as a function of discharge time (the lowest row gives the maximum allowable 5 seconds discharge current)**

Our AGM deep cycle batteries have excellent high current performance and are therefore recommended for high current applications such as engine starting. Due to their construction, Gel batteries have a lower effective capacity at high discharge currents. On the other hand, Gel batteries have a longer service life, both under float and cycling conditions.

## 7. Effect of temperature on service life

High temperature has a very negative effect on service life. The service life of Victron batteries as a function of temperature is shown in table 2.

Average Temperature	AGM Deep Cycle years	Gel Deep Cycle years	Gel Long Life years
20 °C / 68 °F	7 - 10	12	20
30 °C / 86 °F	4	6	10
40 °C / 104 °F	2	3	5

**Table 2: Design service life of Victron batteries under float service**



### 8. Effect of temperature on capacity

As is shown by the graph below, capacity reduces sharply at low temperatures.

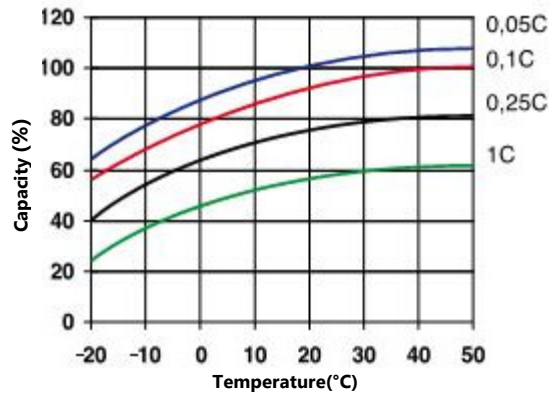


Fig. 1: Effect of temperature on capacity

### 9. Cycle life of Victron batteries

Batteries age due to discharging and recharging. The number of cycles depends on the depth of discharge, as is shown in figure 2.

■ AGM Deep Cycle      ■ Gel Deep Cycle      ■ Gel Long Life

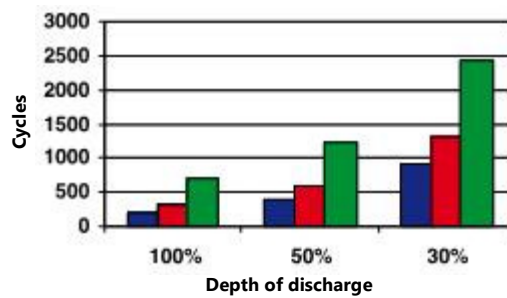


Fig. 2: Cycle life

### 10. Battery charging in case of cycle use: the 3-step charge curve

The most common charge curve used to charge VRLA batteries in case of cyclic use is the 3-step charge curve, whereby a constant current phase (the bulk phase) is followed by two constant voltage phases (absorption and float), see fig. 3.

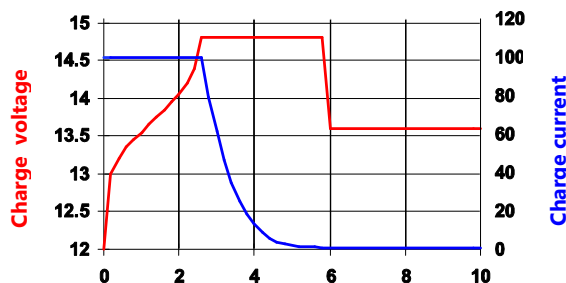


Fig. 3: Three step charge curve

During the absorption phase the charge voltage is kept at a relatively high level in order to fully recharge the battery within reasonable time. The third and last phase is the float phase: the voltage is lowered to standby level, sufficient to compensate for self discharge.

**Disadvantages of the traditional 3-step charge curve:**

- During the bulk phase the current is kept at a constant and often high level, even after the gassing voltage (14,34 V for a 12 V battery) has been exceeded. This can lead to excessive gas pressure in the battery. Some gas will escape through the safety valves, reducing service life.
- Thereafter the absorption voltage is applied during a fixed period of time, irrespective of how deep the battery has been discharged previously. A full absorption period after a shallow discharge will overcharge the battery, again reducing service life. (a. o. due to accelerated corrosion of the positive plates)
- Research has shown that battery life can be increased by decreasing float voltage to an even lower level when the battery is not in use.

**11. Battery charging: longer battery life with Victron 4-step adaptive charging**

Victron developed the adaptive charge curve. The 4-step adaptive charge curve is the result of years of research and testing.

**The Victron four-step adaptive charge curve solves the 3 main problems of the 3 step curve:**

- **Battery Safe mode**  
In order to prevent excessive gassing, Victron has invented the 'Battery Safe Mode'. The battery Safe Mode will limit the rate of voltage increase once the gassing voltage has been reached. Research has shown that this will reduce internal gassing to a safe level.
- **Variable absorption time**  
Based on the duration of the bulk stage, the charger calculates how long the absorption time should be in order to fully charge the battery. If the bulk time is short, this means the battery was already charged and the resulting absorption time will also be short, whereas a longer bulk time will also result in a longer absorption time.
- **Storage mode**  
After completion of the absorption period the battery should be fully charged, and the voltage is lowered to the float or standby level. If no discharge occurs during the next 24 hours, the voltage is reduced even further and the battery goes into storage mode. The lower storage voltage reduces corrosion of the positive plates.  
Once every week the charge voltage is increased to the absorption level for a short period to compensate for self discharge (Battery Refresh mode).

**12. Battery charging in case of standby use: constant voltage float charging**

When a battery is not frequently deeply discharged, a 2-step charge curve can be used. During the first phase the battery is charged with a limited current (the bulk phase). Once a preset voltage has been reached the battery is kept at that voltage (the float phase).

This charge method is used for starter batteries in vehicles, and in uninterruptible power supplies (UPS).

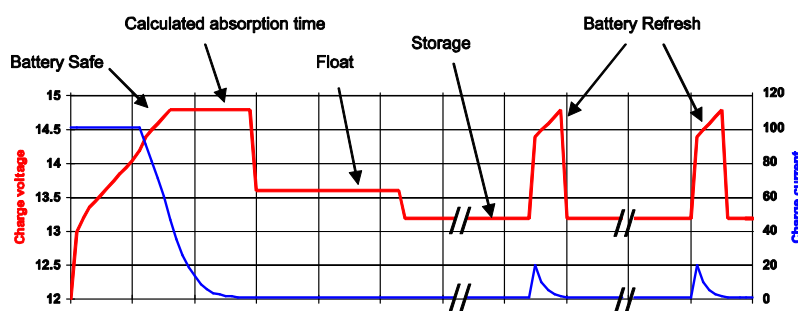


Fig. 4: Four-step adaptive charge curve

**13. Optimum charge voltage of Victron VRLA batteries**

The recommended charge voltage settings for a 12 V battery are shown in table 3.

**14. Effect of temperature on charging voltage**

The charge voltage should be reduced with increased temperature. Temperature compensation is required when the temperature of the battery is expected to be less than 10°C / 50°F or more than 30°C / 85°F during long periods of time. The recommended temperature compensation for Victron VRLA batteries is -4 mV / Cell (-24 mV /°C for a 12 V battery). The centre point for temperature compensation is 20°C / 70°F.

**15. Charge current**

The charge current should preferably not exceed 0,2 C (20 A for a 100 Ah battery). The temperature of a battery will increase by more than 10°C if the charge current exceeds 0,2 C. Therefore temperature compensation is required if the charge current exceeds 0,2 C.

	Float Service (V)	Cycle service Normal (V)	Cycle service Fastest recharge (V)
<b>Victron AGM "Deep Cycle"</b>			
Absorbtion		14,2 - 14,6	14,6 - 14,9
Float	13,5 - 13,8	13,5 - 13,8	13,5 - 13,8
Storage	13,2 - 13,5	13,2 - 13,5	13,2 - 13,5
<b>Victron Gel "Deep Cycle"</b>			
Absorbtion		14,1 - 14,4	
Float	13,5 - 13,8	13,5 - 13,8	
Storage	13,2 - 13,5	13,2 - 13,5	
<b>Victron Gel "Long Life"</b>			
Absorbtion		14,0 - 14,2	
Float	13,5 - 13,8	13,5 - 13,8	
Storage	13,2 - 13,5	13,2 - 13,5	

**Table 3: Recommended charge voltage**

12 Volt Deep Cycle AGM							General Specification
Article number	Ah	V	l x w x h mm	Weight kg	CCA @0 °F	RES CAP @80 °F	Technology: flat plate AGM Terminals: copper
BAT406225080	240	6	320x176x247	31	1500	480	Rated capacity: 20 hr discharge at 25 °C Float design life: 7-10 years at 20 °C Cycle design life: 200 cycles at 100% discharge* 400 cycles at 50% discharge 900 cycles at 30% discharge
BAT212070080	8	12	151x65x101	2,5			
BAT212120080	14	12	151x98x101	4,1			
BAT212200080	22	12	181x77x167	5,8			
BAT412350080	38	12	197x165x170	12,5			
BAT412550080	60	12	229x138x227	20	450	90	
BAT412600080	66	12	258x166x235	24	520	100	
BAT412800080	90	12	350x167x183	27	600	145	
BAT412101080	110	12	330x171x220	32	800	190	
BAT412121080	130	12	410x176x227	38	1000	230	
BAT412151080	165	12	485x172x240	47	1200	320	
BAT412201080	220	12	522x238x240	65	1400	440	

12 Volt Deep Cycle GEL							General Specification
Article number	Ah	V	l x w x h mm	Weight kg	CCA @0 °F	RES CAP @80 °F	Technology: flat plate GEL Terminals: copper
BAT412550100	60	12	229x138x227	20	300	80	Rated capacity: 20 hr discharge at 25 °C Float design life: 12 years at 20 °C Cycle design life: 300 cycles at 100% discharge* 600 cycles at 50% discharge 1300 cycles at 30% discharge
BAT412600100	66	12	258x166x235	24	360	90	
BAT412800100	90	12	350x167x183	26	420	130	
BAT412101100	110	12	330x171x220	33	550	180	
BAT412121100	130	12	410x176x227	38	700	230	
BAT412151100	165	12	485x172x240	48	850	320	
BAT412201100	220	12	522x238x240	66	1100	440	

2 Volt Long Life GEL					General Specification
Article number	Ah	V	l x b x h mm	Weight kg	Technology: tubular plate GEL Terminals: copper
BAT702601260	600	2	145x206x688	49	Rated capacity: 10 hr discharge at 25 °C Float design life: 20 years at 20 °C Cycle design life: 600 cycles at 100% discharge* 1200 cycles at 50% discharge 2400 cycles at 30% discharge
BAT702801260	800	2	210x191x688	65	
BAT702102260	1000	2	210x233x690	80	
BAT702122260	1200	2	210x275x690	93	
BAT702152260	1500	2	210x275x840	115	
BAT702202260	2000	2	215x400x815	155	
BAT702252260	2500	2	215x490x815	200	
BAT702302260	3000	2	215x580x815	235	

**Other capacities and terminal types: at request**

\* End of discharge voltage: 10,8 V for a 12 V battery